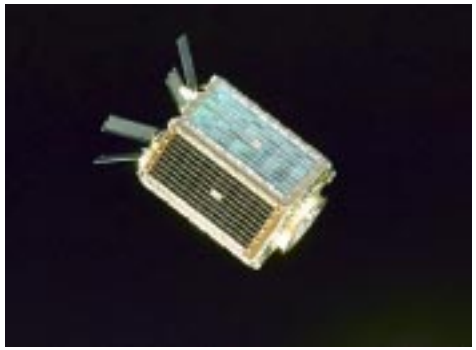
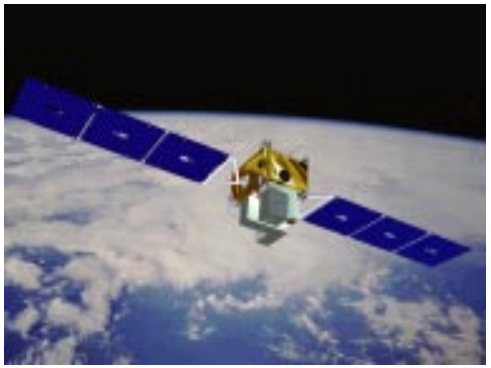
MightySat I Overview

- **MightySat Mission: Technology Demonstration**
  - – Provide timely and inexpensive space demonstration of Air Force Research Laboratory (AFRL) technologies
  - – Accelerate the transition of emerging space technologies to operational use
  - – Provide space systems experience for AFRL personnel





•MightySat I

- – Single mission Pathfinder
- – Demonstrates five AFRL technologies
- – Launched in Dec 98 from STS-88
- – Total Mission Cost of about $6M

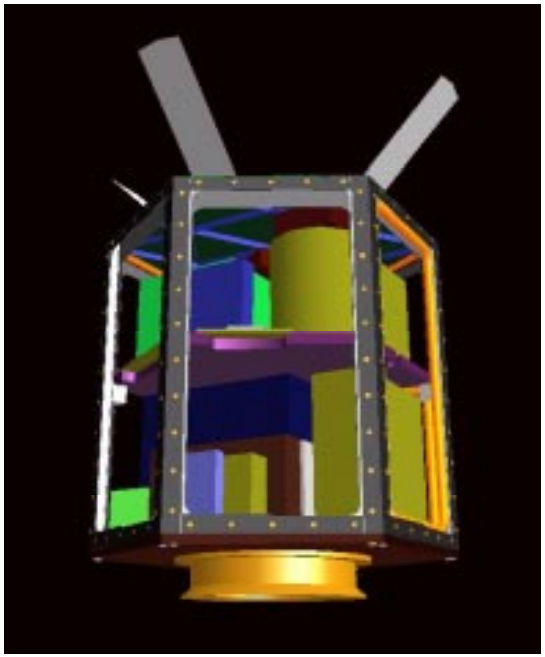
•MightySat II

- – Long term space access for AFRL
- – Up to 5 missions, 18-24 months apart
- – First launch in Apr '00; 7 Experiments
- – Total Mission Cost Goal of <$12M

MightySat I Overview

Spacecraft Characteristics:

- 6-sided 20.5” Height; 19” Diameter Structure
- 140 Lb Satellite, 113 Lb Spacecraft Bus
- 15 to 30 W Orbit-avg Power Generation
- 12W Average Spacecraft Power Usage
- Spin Stabilized W/ 5 Deg Attitude Knowledge
- 1.2 MB On-board Memory
- **Class D, Low-cost, Single-string Systems**



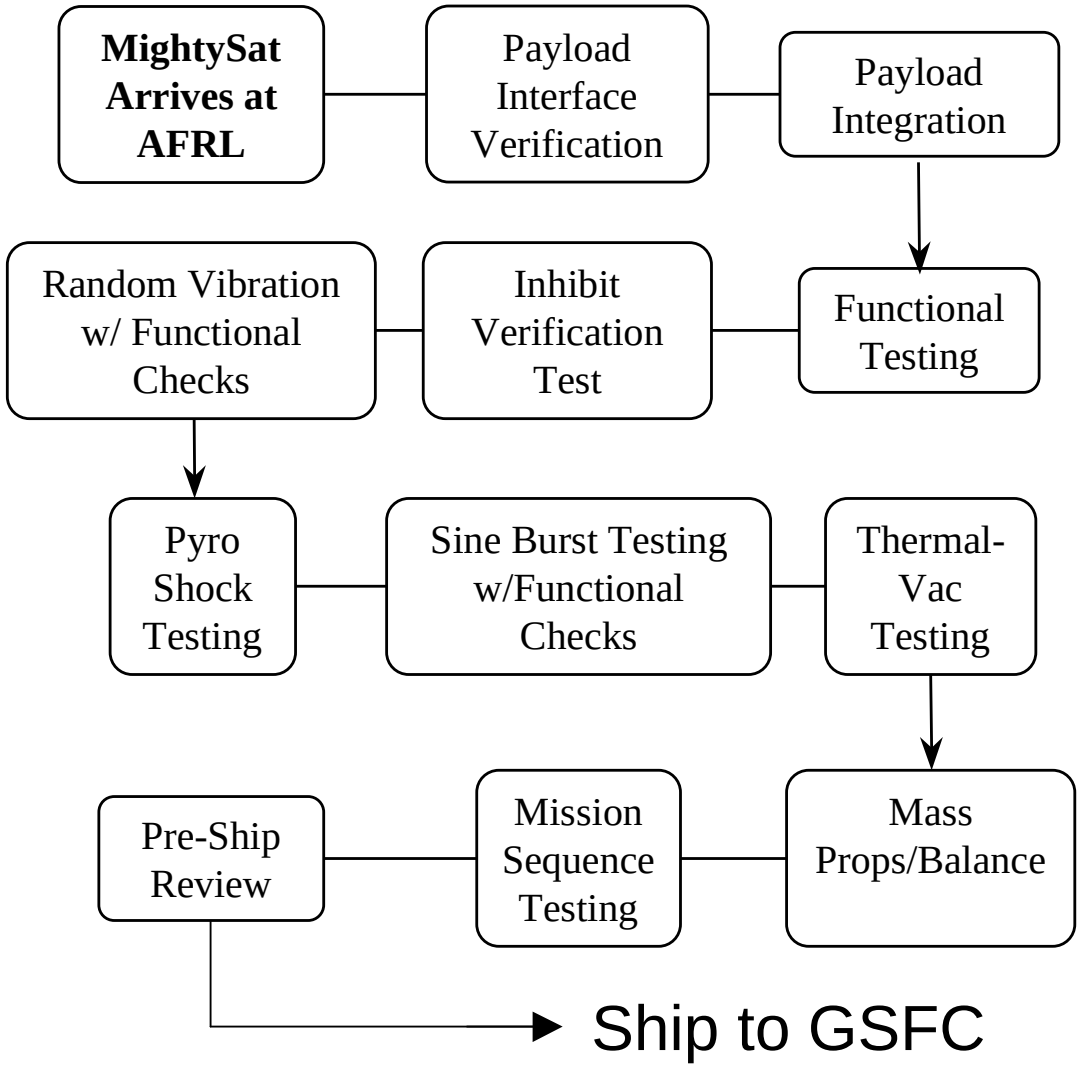
Payloads:

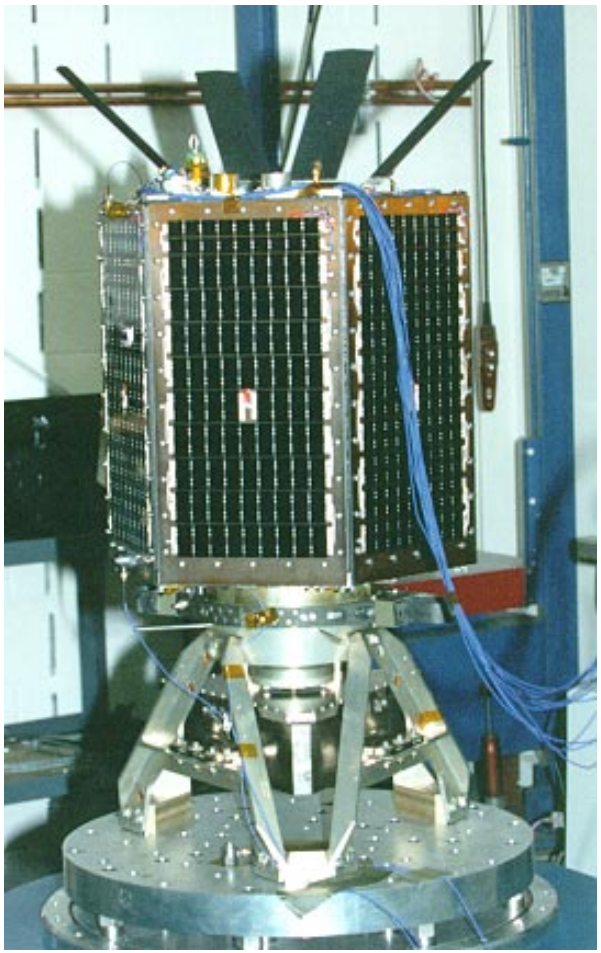
- Advanced Composite Structure
- Advanced Solar Cell Experiment (ASCE)
- Shape Memory Actuated Release Devices (SMARD)
- Microsystem and Packaging for Low Power Electronics (MAPLE-1)
- Microparticle Impact Detectors (MPID)

MightySat I Overview

- **Operations**
  - UHF Communications at 2.4/9.6 kbps
  - Two Dedicated UHF Ground Stations - KAFB, NM and Dulles, VA
  - Mission Planning on PC's by the Air Force Space and Missle Systems Center Test and Evaluation Directorate (SMC/TE)
  - Automated Contact Execution
  - 3-4 Person Operations Crew
- **Operations Preparation**
  - Three Mission Rehearsals
  - Testing Telemetry Modified to Reflect "Anomalies"

KAFB Integration & Test





GSFC/KSC Integration & Test

- GSFC
  - Magnetic Calibration Testing
  - RF Testing
  - Low Voltage Troubleshooting
  - Startup and Inhibit Testing
  - Command and Telemetry Validation
  - Can Integration
- KSC
  - Final Functional Testing
  - Orbiter Installation
  - Battery Top Charge and Inhibit Verification
  - Final Close Out

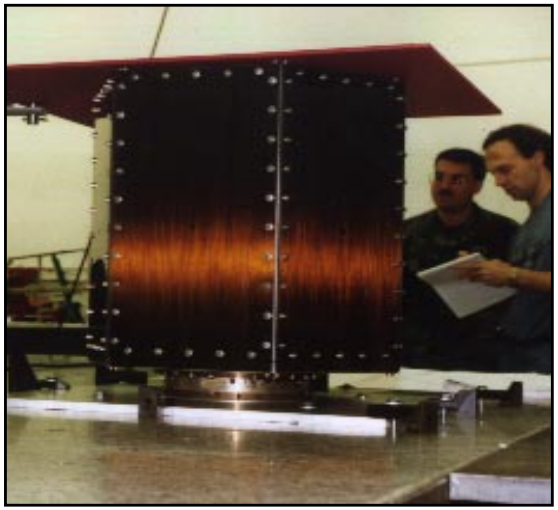
Launch & Early Orbit

- **STS-88 Launched 4 Dec 98**
- **MightySat I Ejected on 15 Dec 98, 1900 MST**
- **Contact Made One Hour after Ejection (at 2º elevation!)**
- **MightySat I Very Healthy from the Start**
  - -- Safety Inhibit Unit operated flawlessly
  - -- All state-of-health nominal
- **Satellite Check-Out Completed in 7 Days**
  - -- On-board Clock Set; Telemetry Collection Verified
  - -- Power, Thermal Systems Verified
  - -- Spin-Stabilization Established (3 rpm around Y axis)
  - -- ASCE, MPID, MAPLE-1 Payloads Initiated
- **Initial Ground Station Problems**
  - -- Doppler Correction
  - -- Ground Station RF Interference

Composite Structure

Summary

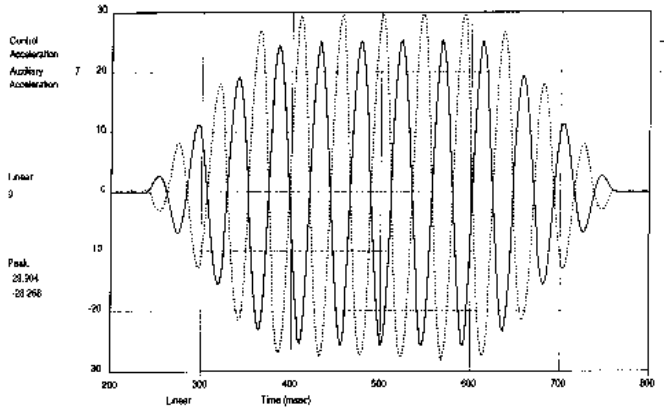
- K1352U graphite fiber with Cyanate Resin
- SnapSat™ manufacturing technique
- Composite frames and solar array substrates
- Honeycomb Decks, Isogrid Top Deck
- Fabricated by Composite Optics, Inc.



Objective: Demonstrate Experimental Structure

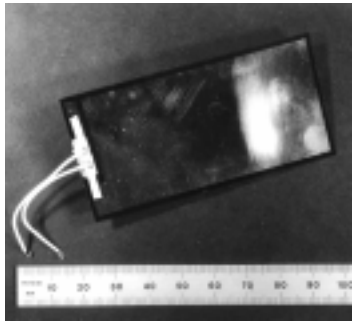
Results to Date:

- Structure Passed All Required Ground Testing
  - Addressed Significant NASA Safety Issues
  - Some Rework Required
- Structure Survived Launch and Ejection Loads



MPID

Microparticle Impact Detector



Summary

- Two 3” x 1-1/2”, approximately 0.013” thick detectors
- Mounted to underside of satellite bottom deck
- Total impact detection area of 3.7 in^2.
- Measure micron-sized (1 - 200μm) particle impacts

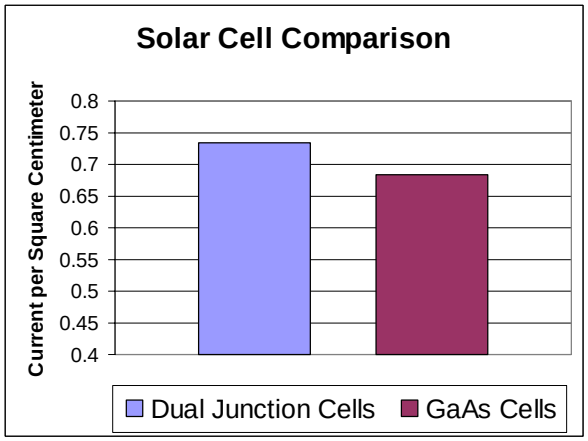
Objective: Add to Mapping Database for Identification and Prediction of Debris Particle Clouds

Results to Date:

- No Impacts Detected to Date
- Small Detector Size, Spinning Satellite Results in Low Impact Probability

ASCE

Advanced Solar Cell Experiment



Summary

- 520 2cm x 4cm GaAs Cells
- 108 2cm x 2cm GaInP/GaAs Dual Junction Cells
- Seven Solar Panels
- Provides All Power for MightySat I

Objectives:

- Space Qualify Dual Junction Cells
- Evaluate On-Orbit Efficiency
- Validate Composite Subatrate

Results to Date:

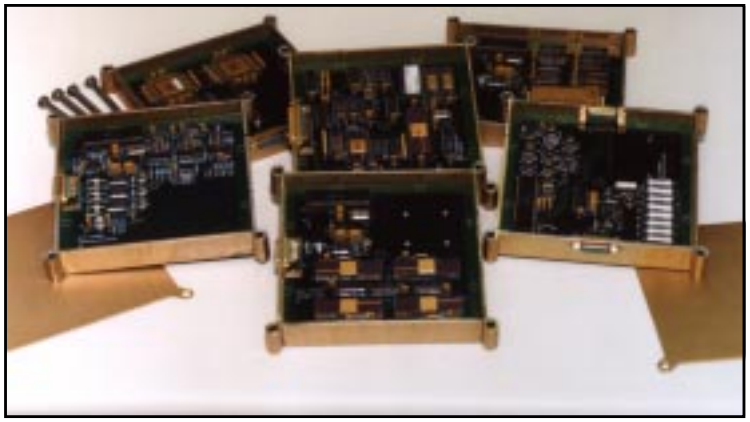
- No On-Orbit Degredation Noted
- No Problems with Composite Solar Array Substrate
- Experimental Cells 6-8% more efficient than GaAs Cells

MAPLE 1

Microsystem & Packaging Experiment for Low Power Electronics

Summary: Five Experiment Boards

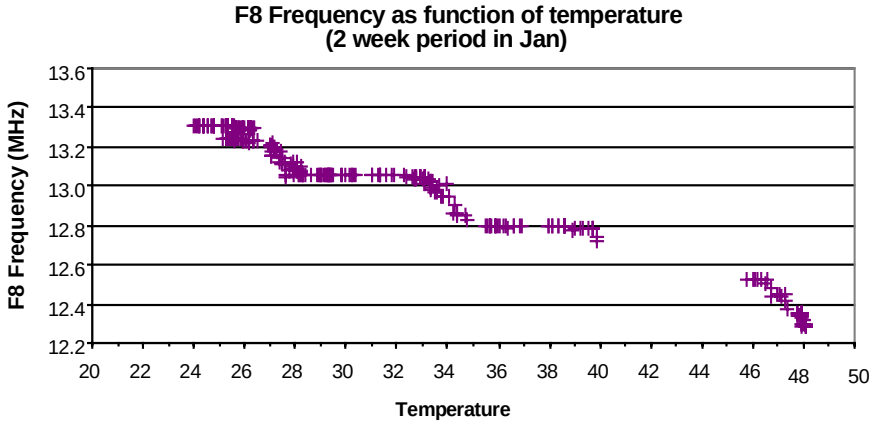
- Advanced Electronics Board (AEB)
- Packaging Reliability Board (PRB)
- Solid State Recorder Board (SSRB)
- Environmental Monitor Board
- Micro-electro-mechanical Systmes (MEMS) Evaluation Board (MEB)



Objective: Evaluate Emerging Electronics and Packaging Technologies in Space

Results to Date:

- PRB showed Odd Frequency Dependence on Temperature
- MEB Captured SMARD Events
- Minimal Errors on AEB and SSRB



SMARD

Shape Memory Actuated Release Devices

Summary:

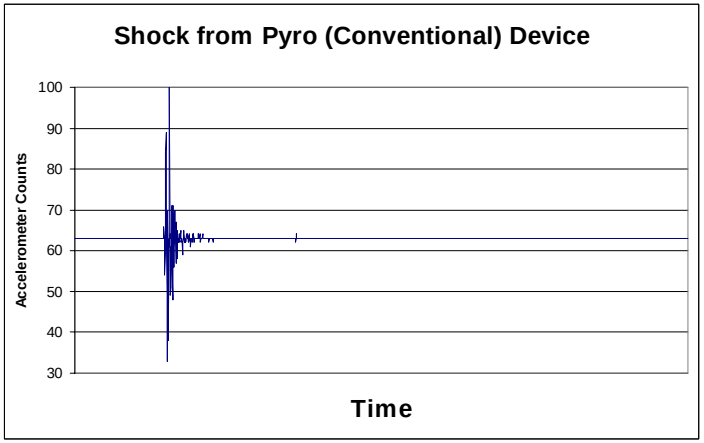
- Shape Memory Alloy (Nitinol)
- Two SMA Devices, Two Conventional Devices (NSI Pyro, G&H Linkwire)
- Release 0.25” Bolt
- Accelerometer, Load Cell Measurement
- Lockheed Martin Design

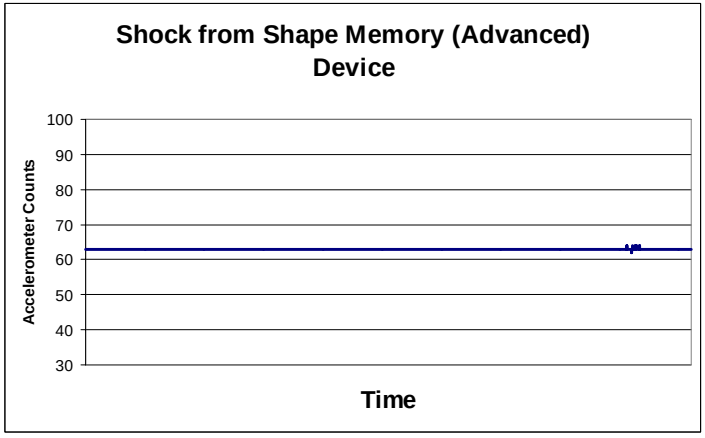
Objective:

- Demonstrate Low-Shock Release
- Compare to Conventional Release Devices

Results to Date:

- All Four Devices Fired Successfully in May 1999
- Shape Memory Devices Produced Considerably Less Shock





Lessons Learned

- Testing
  - Test It the Way It Will Fly
  - If It Hasn't Been Tested, Assume It Won't Work
- Shuttle Safety Process
  - Design Good Electrical Inhibits
  - Try to Get Through the Process Before Building Hardware
- Composite Structure
  - Not Worth It for Weight Savings In This Case
  - Test With an Engineering Model First
- Ground System
  - Don't Neglect It
  - Difficult to Test Completely
- Safe Mode - Make It Simple and Robust

MightySat I's Future

- No Spacecraft Resets or Major Anomalies So Far
- Continue Gathering Data from MPID, MAPLE, ASCE
- Operate Nominally as Long as Possible
- Burn-in Expected Around 7 Nov 99